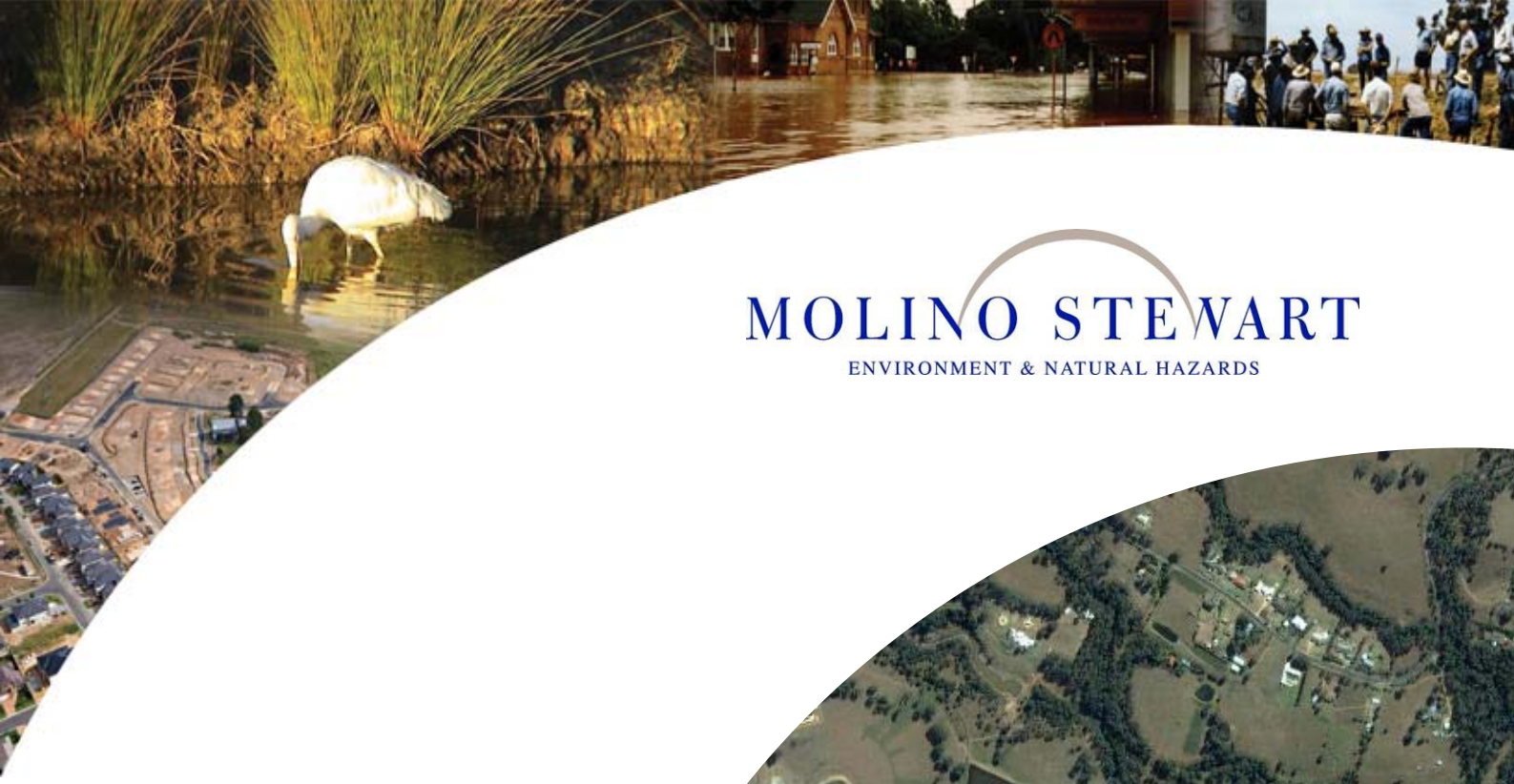
Attachment 11 to Item 3.1.1.

Flood Evacuation and Bushfire Safety Report

Date of meeting: 21 November 2024
Location: Audio-visual link
Time: 10am



MOLINO STEWART

ENVIRONMENT & NATURAL HAZARDS

North Richmond Release Area Flood and Bushfire Safety Evaluation

final report

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North Richmond Release Area
Flood and Bushfire Safety Evaluation

FINAL REPORT

for

North Richmond Joint Venture

by

Molino Stewart Pty Ltd
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AUGUST 2009

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1 BACKGROUND

North Richmond Joint Venture (NRJV) is a consortium of Buildev Development and IMA. It is seeking a rezoning of its land holdings at North Richmond for urban development. NRJV has already received from the Director-General of the Department of Planning a Seniors Housing Certificate of Site Compatibility for part of the site. It expects to seek approval in the future for the remainder of the site to be rezoned for urban development.

One of the matters listed for resolution in the Director-General's certificate is:

"confirmation by the State Emergency Services that existing infrastructure is adequate (or can be provided) to evacuate residents during flood and bushfire events"

This report has been prepared not only to assess the adequacy of infrastructure for evacuation of the proposed seniors living development in the event of flood or bushfire but considers this issue for the full development potential of the entire site.

As well as responding to the above requirement of the Site Compatibility Certificate the report responds to evacuation provisions of clause 27(2) (Bush Fire Prone land) of State Environmental Planning Policy (Housing for Seniors or People with a Disability) 2004.

This report has been prepared by Steven Molino of Molino Stewart who has extensive experience in floodplain management and, in particular, flood risk evaluations in the Hawkesbury Nepean Valley. A copy of Steven's curriculum vitae can be found in Appendix A.

Inputs on bushfire risks were provided by Graham Swain of Australian Bushfire Protection Planners.

2 PROJECT DESCRIPTION

2.1 The Site

NRJV is seeking to rezone its land holdings at North Richmond which are located on the north side of the Hawkesbury River and to the west of the current North Richmond settlement. Aerial photos show the site to be largely cleared rural lands as shown in Figure 1. The area delineated on the photo shows the 180.3 ha NRJV land as well as a much smaller adjoining block (Lot 26 DP 104289) which is part of a future residential investigation area. For the purposes of this report we have considered potential development of all of the land within the purple boundary.

The site is bounded by Grose Vale Road to the south and west, Bells Road to the west, Redbank Creek to the North and the residential areas of North Richmond to the east.

The site is located on relatively elevated land that overlooks the Hawkesbury River. Up to 13 farm dams and waterbodies occupy the site as well as some scattered, presumably remnant, tree cover.

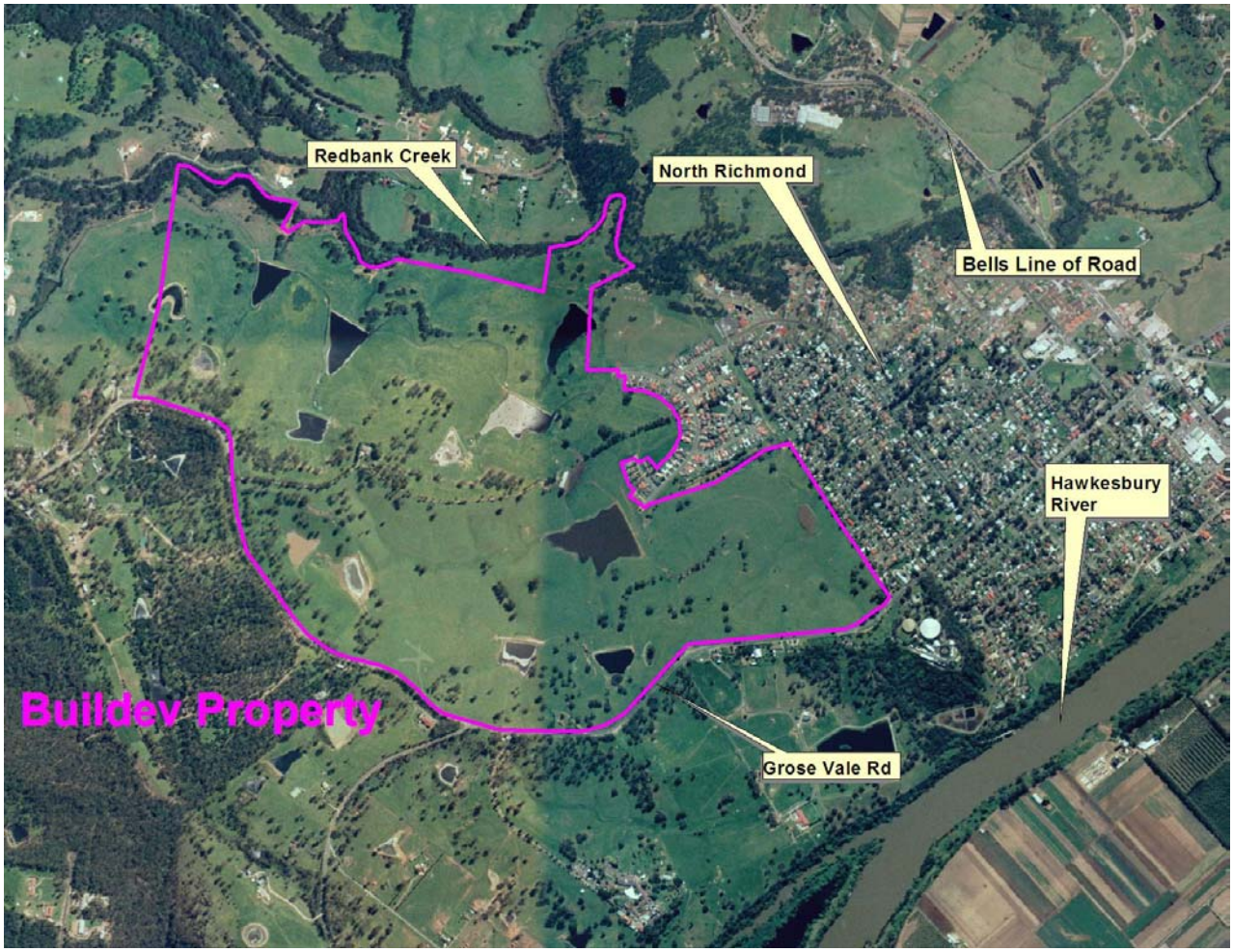

Figure 1: Aerial Photo of the NRJV Site

2.2 Proposed Seniors Housing Development

The first stage of the development is a proposed seniors living precinct on 28 ha adjacent to the existing North Richmond urban area. A concept of the development is shown in Figure 2. NRJV has received a Seniors Housing Certificate of Site Compatibility from the Director-General of the Department of Planning for this part of the site. The Director-General's certificate restricts the development to a maximum of 467 dwellings, 102 residential care units and 180 hostel beds.

This flood study is to assist Council in the development assessment of the application for seniors development on a portion of a 180.3 hectare site that is also the subject of proposal for land release. Of this site the subject DA applies to approximately 15 hectares which is a portion of the 32 hectare area that gained site compatibility for senior's living.

The initial development application is for approximately 200 dwellings and a 180 bed nursing home on 15 hectares. For the purposes of this evaluation, it is assumed that the area will be developed up to these maximum permissible levels. However, the proposed development for which approval will be sought will consist of:

- Hostel style aged are accommodation (102 beds)
- Serviced self-care housing (about 170 dwellings)
- A Residents Club facility including gymnasium, pool, theatrette, commercial kitchen and eating area, other rooms, outdoor sports facilities such as tennis courts
- A dedicated area for boat and caravan storage

The new development will be accessed initially through North Richmond via Arthur Philip Drive as shown in Figure 2. When further urban development takes place there will also be access from the seniors living precinct to Gross Vale Road through the new urban development.

It is proposed to provide the precinct with a private transport facility with at least two, ten seater buses.

Figure 2: Concept of Proposed Seniors Housing Development

2.3 Proposed Urban Development

The remaining 155 hectares would be able to accommodate urban development ranging from standard lots to larger lots. It is envisaged the overall land release proposal has the potential to accommodate in the range of 1000-2000 residential lots. This would be integrated to include the dwelling yield from the proposed senior's development.

This compares to 1,582 dwellings in the 2006 census for the suburb of North Richmond which for census purposes extends north east to Wire Lane and Kurmond Road.

There were 4,474 people living in that area in 2006.

3 FLOODING

3.1 Nature of Flooding in the Area

The Hawkesbury River has a catchment of about 11,000 square kilometres upstream of Windsor in the Hawkesbury Local Government. The normal river level is only 0.5m above sea level at this point but is 100km from the ocean. Downstream of Windsor the river enters a deep sandstone gorge at Sackville.

When flood waters reach the gorge at Sackville the lack of elevation and the constriction in the river means that the water flows downstream much more slowly than it is entering the floodplain upstream. This causes the river to rise to considerable depths such that the 1 in 100 flood is 17.5m above sea level and the probable maximum flood (PMF) is 26.5m above sea level at North Richmond. The largest flood recorded in the valley occurred in 1867 and reached 19.5m at Windsor (about 19.7m at North Richmond). There is sedimentary evidence that a flood exceeded 20m at some time under current climatic conditions. These floods cover a floodplain with an area of about 400 square kilometres.

The more frequent floods in the river would cover the Richmond bridge for up to three days while floods as big as the 1867 flood or larger would be above the bridge level for five or six days.

The extent of the 100 year, 1867 and PMF floods are illustrated in Figure 3. This shows that the North Richmond area is above the PMF level and therefore is not directly at risk from riverine flooding under any of the planned or reasonably foreseeable flood events.

Redbank Creek along the northern boundary of the NRJV property, as well as several other ephemeral water courses which cross the land, can also flood. These would rise and fall over the space of a few hours and the maximum depth of flooding is only likely to be a few metres and be confined to a small area within tens of metres of the creek bank.

Both local and riverine flooding impacts on the site are considered in this report, including the indirect impacts on the North Richmond area which would likely occur In the event of a major flood in the floodplain.

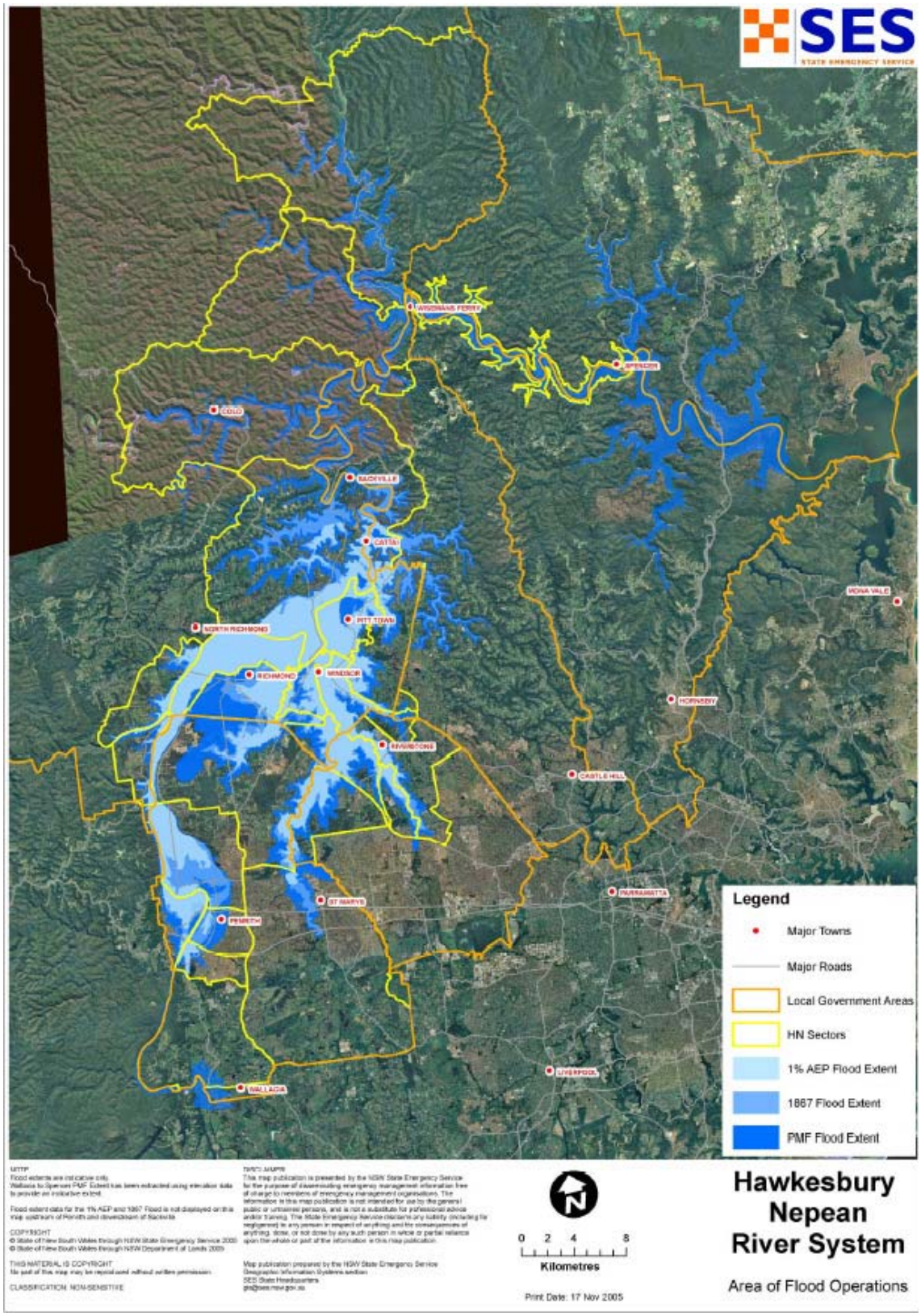

Figure 3: Map of Hawkesbury Nepean Flood Area (HNFESP, 2006)

3.2 Government Policy

3.2.1 Department of Environment and Climate Change

The NSW Floodplain Development Manual (The Manual) sets out guidelines for development in floodplains. While it is not mandatory to follow the manual, local government generally does so because it represents best practice in this regard.

The Manual advocates a merits based approach to floodplain development with consideration of the consequences of flooding up to the PMF. This includes consideration of the consequences for property and people. The Manual generally recommends residential floors levels to be set at the 1 in 100 level plus an allowance for freeboard. This is referred to as the flood planning level (FPL)

3.2.2 Department of Planning

In January 2007, the Minister for Planning issued a ministerial direction under S117 of the *Environmental Planning and Assessment Act 1979*.

It directs that:

'(4) A draft LEP must not impose flood related development controls above the residential flood planning level for residential development on land, unless a council provides adequate justification for those controls to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).

'(5) For the purposes of a draft LEP, a council must not determine a flood planning level that is inconsistent with the Floodplain Development Manual 2005 (including the *Guideline on Development Controls on Low Flood Risk Areas*) unless a council provides adequate justification for the proposed departure from that Manual to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).'

At the same time the minister issued a Guideline which states in part, in reference to the Manual:

'Despite noting the FPL for typical residential development would generally be based around the 100 year flood plus a freeboard of typically 0.5 metres, the Guideline *"confirms"* that *"unless there are exceptional circumstances, councils should adopt the 100 year flood as the FPL for residential development'.*

The Guideline requires that this be adopted in any new local environment plan. It specifically states that it does not apply to group homes and seniors housing.

What is meant by "exceptional circumstances" has not been tested to date.

3.2.3 Hawkesbury City Council

Currently Hawkesbury City Council's FPL is the 1 in 100 level without an allowance for freeboard.

For those areas at North Richmond affected by flooding from the Hawkesbury Nepean River, this would be about 17.5m Australian Height Datum (AHD). However, application of the Guideline would require this to be raised to 18.0m AHD including freeboard for any new LEP.

Land can also be affected by flooding from local water courses. The flood levels along these would need to be calculated by specific studies for those smaller catchments and the FPL be no lower than the 1 in 100 level along them.

Section 25, Clause 5 of the Hawkesbury LEP states:

'The Council shall, in the assessment of a development application, consider the flood liability of access to the land and, if the land is within a floodway, the effect of isolation of the land by flooding, notwithstanding whether other aspects of this clause have been satisfied.'

3.2.4 State Emergency Service

In recent years it has been NSW State Emergency Service (SES) practice to object to proposed developments in the Hawkesbury LGA which increases the residential population below the PMF level of the Hawkesbury Nepean River without adequate provision for timely evacuation of dwellings in accordance with the SES Hawkesbury Nepean Flood Emergency State Plan.

Where short duration flooding from local water courses is the only flood threat to people and property, the SES may recommend people staying within their buildings if the flood hazard is low.

Seniors accommodation presents particular challenges with regard to evacuation because of the high proportion of residents with low mobility and/or lack of their own transport.

3.3 Regional Flood Impacts

3.3.1 Overview

As indicated in Figure 3, a large proportion of Richmond, Windsor, Penrith and adjoining areas would be under water in a major flood. The more frequent floods in the river would cover the Richmond bridge for up to three days while floods as big as the 1867 flood or larger would be above the bridge level for five or six days. These floods would likely cause major damage to property and infrastructure on the floodplain and place human life in the area at significant risk, leading to mandatory evacuation for extended periods.

By contrast, the North Richmond area will remain above floodwater level, even in the PMF event and so would not suffer any significant direct damage to property nor direct risk to human life.

3.3.2 Comparison to Other Development Sites

As part of the initial assessment of the development potential of the NRJV site in North Richmond, a comparison of flood impacts was undertaken vs four other proposed urban development sites of a similar size to the NRJV proposal within the Hawkesbury LGA:

- North Bligh Park;
- Vineyard;
- Pitt Town; and
- Wilberforce.

The elevation and flood level results outlined in Table 1 show the NRJV North Richmond site to be located on much higher ground than all other comparable sites. Importantly, the minimum elevation of land to be developed is above the PMF level which effectively rules out any residences constructed on this land being inundated. The

area of land below the PMF (approximately 2% of the subject land) consists of riparian land along Redbank Creek on the northern extremity which is not to be developed.

In comparison to the other proposed development sites listed, all have land below17.3m AHD, the level of a 1 in 100 year flood. Any land below this level is unable to be developed according to the Hawkesbury Local Environment Plan 1989. This may significantly reduce development yield at some of these sites.

The proposed development at North Bligh Park has no areas above the PMF level. This area would have issues if residents failed to evacuate and the water rose above the highest ground levels. The North Bligh Park land has a 1 in 1,000 probability of being entirely covered by floodwaters.

Both Pitt Town and Vineyard subject lands have less than 10% of their sites above the PMF level. Such areas could be used as temporary refuge for residents who fail to evacuate in floods up to and including the PMF.

Wilberforce has 75% of land above 26.4m AHD (PMF level) but the southwest portions of the site would be flooded in events between the 1 in 100 year and the PMF event.

In summation, based on the topography of the site and the level at which various floods may reach, the NRJV site has no direct flood risk to residencies where as all of the other sites have some risk of flooding.

Table 1: Elevation, flood and evacuation characteristics of proposed development sites in the Hawkesbury LGA

Site	**Minimum elevation of developable land (m AHD)**	**Maximum elevation on site (m AHD)**	**Probability of highest point being inundated**	**Proportion of site below PMF (%)**	**SES Flood Evacuation Classification**	**Evacuation route capacity**	**Evacuation Triggered if flooding is expected to exceed (m AHD)**	**Chance in any year of evacuation being triggered**
NRJV (N. Richmond)	30[1]	>50	Nil	~2*	Indirectly affected	Not constrained	Not necessary	nil
N. Bligh Park	17.3 (4)[2]	20.5	1 in 1000	100	Low flood island	900 additional lots [3]	17.3m AHD	1 in 100
Wilberforce	17.3 (17)[2]	50.3	Nil	~25	Accessible by road	Not constrained	17.3m AHD	1 in 100
Pitt Town	17.3 (12)[2]	28.5	Nil	95	Low flood island	1,000 additional lots	16m AHD	1 in 60
Vineyard	17.3 (2.9)[2]	35.7	Nil	90	Low flood island	Unknown	23m AHD[4]	<1 in 1,000

1. A small section of riparian corridor is below 26m AHD but this is not suitable for urban development due to the terrain
2. Figures in parentheses signify the absolute minimum elevation of the subject lands
3. If additional evacuation infrastructure were provided
4. Estimated from orthophoto maps – Windsor (U82757, 82758) and Riverstone (U82671, U82672)

3.4 Site Flood Impacts

3.4.1 Direct

a) Riverine Flooding

With the exception of a small strip of riparian land along its northern boundary, none of the NRJV site is below the PMF level (26.5m AHD). The land which is below the PMF will be within an open space corridor along Redbank Creek. The seniors living precinct will be above 30m AHD. Therefore flooding on the Hawkesbury Nepean River will not directly impact on any of the proposed development.

b) Local Flooding

Redbank Creek and the ephemeral water courses through the site will flood from time to time and affect parts of the site. No flood studies had been completed for these watercourses at the time of writing but any new buildings on the site would have to have floor levels at or above Hawkesbury Council's FPL which will be set no lower than the 1 in 100 flood level. As this is a greenfields urban development, it will be possible to design riparian corridors and building footprints so that is achieved.

Should flood occur that exceed the 1 in 100 level only a few of the properties are likely to be affected because the depth range of these floods will be small and the undulating topography of the site will place most of it above the reach of flood waters.

The seniors living precinct abuts one of these ephemeral watercourses where it enters a pipe system and flows under the existing North Richmond urban area. There is potential for water to pond to greater depths and extents in this area than along some of the other ephemeral water courses on the site which do not have their flow constricted in this way.

Upstream detention basins and appropriate building designs provide scope to mitigate the direct impacts of flooding on buildings in events larger than the 1 in 100 flood.

3.4.2 Indirect

a) Riverine Flooding

The Hawkesbury Nepean Flood Emergency Sub Plan has been prepared by the NSW State Emergency Service (SES) to set out a plan of action in preparation for and response to major floods in the Hawkesbury Nepean Valley (SES 2005).

For the purposes of the plan, each locality in the valley is classified according to its topography and evacuation routes. The categories are:

- Flood Islands (Category FL and FH);
- Areas Accessible Overland (Category O);
- Areas Accessible by Road (Category R);
- Landlocked Areas (Category L); and
- Indirectly Affected areas (Category I).

In the Plan, North Richmond is classified by the SES as Accessible by Road. These are areas which can be progressively evacuated along a road as flood waters rise and

over the land. This classification has been applied by the SES to the existing North Richmond development.

It is noted however that all of the proposed North Richmond development site is above the PMF. This flood free area would therefore fall into the indirectly affected area categories. That is, it will not be directly affected by riverine flooding but utilities and services may be lost due to flooding.

The following explains how floods on the Hawkesbury Nepean could indirectly affect development on the North Richmond site.

i) Road Access

North Richmond and Windsor bridges will close when the river reaches about 8.4m AHD at North Richmond. This would cut the most direct and second most direct access across the river for North Richmond residents.

Residents can cross the river via Bells Line of Road, the Great Western Highway and the M4 Motorway Bridge. This involves a detour of about 100km but is not affected by flooding of the Hawkesbury Nepean River right up to the PMF.

The duration of such a disruption would vary (SWC 1995). In a 1 in 5 flood the bridges would be under water for 2.5 days, in a 1 in 20 flood for 3.5 days, in a 1 in 100 flood for 4.5 days and in a PMF for 6 days or more. This assumes that the bridge and approach roads are intact after the flood.

It is likely that in a 1 in 100 flood or bigger these bridges could be severely damaged or even washed away and roads across the floodplain around Richmond would be scoured. In these more extreme events the reality is likely to be that the alternative access would be needed to be used for months.

Of course that would also depend on the purpose that people had for crossing the river. If it were simply for regular food supplies then the shops in North Richmond would be able to provide those supplies although they would have to be restocked more regularly by deliveries approaching from the west.

If the purpose of crossing the river was to visit a destination on the floodplain then that destination would probably be damaged or vacated as a result of a flood big enough to damage the bridge so an alternative destination would have to be found in any case. Lithgow or Katoomba which are both within one hour's drive would probably have suitable alternatives.

If the purpose was to reach a destination on the other side of the floodplain then the detour would need to be taken until the access across the entire floodplain was restored.

Given the low probability of this occurring, and the more urgent needs of those directly affected by flooding, it is unlikely that this inconvenience in any flood would be sufficient to warrant the SES to call for the evacuation of North Richmond.

ii) Electricity

Integral Energy is responsible for electricity distribution throughout the Hawkesbury LGA. North Richmond is supplied out of the Hawkesbury Transmission Substation as is most of the Hawkesbury LGA. Most lines out of this substation would be shut down when water levels reach about 13m AHD which would happen in a flood approaching a 1 in 20 event.

Providing the lines and substation are not damaged by flooding, the power would be able to be restored soon after the water dropped below this level. In these circumstances North Richmond could be without power for a few days.

When flooding exceeds about 20m AHD at Windsor (about a 1 in 500 flood) the Hawkesbury Transmission Substation would be damaged and it could take weeks or even months to restore power not only to North Richmond but more than 25,000 properties in the region that are dependent on that power. This would include those properties in the localities listed in Table 1 which had remained above the floodwaters. It would also include almost every property which is above the PMF level west and north of the Hawkesbury River between Yarramundi and the McDonald River.

It may be possible to incorporate energy efficiency, renewable energy and emergency power supply options in the North Richmond development to reduce the risks and consequences of loss of grid supply due to flooding. Some renewable energy options such as extensive use of solar panels may be able to generate sufficient emergency power for the new and existing parts of North Richmond.

The provision of emergency power would be particularly important in the seniors living precinct where the medical conditions of residents would mean many would be dependent on electrical equipment to maintain their health.

Given that flooding is only one of many ways in which power supply could be interrupted, it is unlikely that loss of power through flooding would be sufficient a trigger to require the evacuation of the proposed North Richmond development.

iii) Telecommunications

The terrestrial telephone lines at North Richmond are connected to the Richmond Switching Centre. Richmond Switching Centre will not be directly damaged until the flood waters reach 22m AHD (about a 1 in 1,000 flood) but will be reliant upon emergency power supplies from on site generators from the time water exceeds 13m AHD because of failure of the electricity supply network.

The mobile phone system in the region has been significantly upgraded since the last studies on the effects of flooding were undertaken in 2001 however it is likely that Richmond Switching Centre remains a key component in the mobile phone networks and any flood impacts on it are likely to impact on mobile phone services to North Richmond.

Given the low probability of flooding cutting telephone access to North Richmond, and the non-critical nature of this service, it is unlikely that loss of telecommunications would be sufficient reason to evacuation North Richmond.

iv) Water Supply

North Richmond Water Treatment Plant treats and supplies reticulated drinking water to North Richmond. While some of the sludge lagoons at the plant would be submerged in floods exceeding 18m AHD, this would not affect the operation of the plant and even a PMF would not directly impact on the plant's function.

Loss of electricity supply poses a greater threat to the plant's operation with the plant having to shut down due to loss of power when the flood level exceeds 13m AHD. Power supply to key pumping stations would also be cut off at about this level. This would not prevent water being supplied to customers as water stored in elevated tanks within the system could be stretched out to as long as two weeks if severe water restrictions were imposed.

Any properties on the floodplain east of the River which were not evacuated would have similar risks of loss of water supply because they get their water from North Richmond Water Treatment Plant although should the North Richmond bridge or its approaches be damaged by floodwaters, the pipeline supplying east of the River could be cut.

The proposed new development can use water efficient designs, rainwater harvesting and on-site recycling to reduce its dependence on treated water from North Richmond Water Treatment Plant. The need to evacuate due to lack of drinking water is unlikely.

v) Gas Supply

North Richmond does not have reticulated a gas supply.

vi) Sewerage

The proposed development will either have its own packaged sewage treatment system or be connected to North Richmond Sewage Treatment Plant (STP).

The pumping stations which feed sewage to either treatment system would shut down when their electricity supplies are cut at about 13m AHD and untreated sewage would build up in their pump wells. However, there is scope in the new development to provide emergency power to pumping stations to reduce the risk of the wells filling and overflowing before power is restored. This would be particularly important as supplies from the existing power network could take a few days to restore.

Emergency power at a new package STP on the site would reduce the risk of treatment failure.

Water efficient urban design initiatives in the new development including on site recycling and reuse could reduce the volumes of sewage that would need to be transported and treated and therefore further reduce the risk of untreated overflows.

There can be a very low risk of sewage treatment failure due to flooding and were it to occur it is unlikely to necessitate the evacuation of the entire development.

vii) Medical Services

According to the report on Social Infrastructure Assessment – North Richmond (Urbis 2007), there are pharmacies, doctors and dentists in North Richmond so loss of road access due to flooding will not create any significant issues for access to these medical services.

There are four hospitals within reasonable proximity to the site:

- Hawkesbury District Hospital/Windsor Hospital, Windsor – Approx 8km east of the site A 127 bed private hospital, services includes emergency services, surgical services, 24 hour medical centre (bulk billing), community nursing.
- Nepean District Hospital, Penrith - Approx 20km south of the site. This is a 420-bed major referral hospital.
- Lithgow Hospital, Lithgow - Approx 75km west of the site. This consists of a 46 bed public hospital, 14 bed private hospital, 13 bed nursing home, 31 hostel type units and a comprehensive community health centre. 24 hour emergency services operate.
- Blue Mountains Hospital, Katoomba – Approx 50km southwest of the site. This is an 86-bed general hospital

Flooding would cut off all access from North Richmond to the hospital at Windsor because Windsor effectively becomes an island. In floods exceeding 16m AHD the hospital itself would be directly impacted by flooding but would be reliant upon emergency power supplies before that occurred.

All of the other hospitals would not be directly or indirectly affected by flooding of the Hawkesbury Nepean River. Loss of road access directly across the river will increase the travel time to Nepean Hospital to close to two hours while the travel time to Lithgow and Katoomba hospitals would remain at the current one hour.

This increased travel time is only likely to be an issue for medical emergencies but would be less of an issue were a suitable helicopter landing areas to be set aside adjacent to the seniors living precinct. The existing oval on Arthur Philip Drive may be suitable for this purpose.

b) Local Flooding

Local flooding is only likely to affect internal roads to the development. When only the seniors living precinct is developed this could result in access being cut to this development for a few hours in extreme floods.

The chance of this happening will depend upon the design of the roads and bridge which connect it with Arthur Philip Drive as well as the amount of flood detention storage provided along the water course.

This is only likely to create a problem should there be a medical emergency in this time and the provision of a suitable helicopter landing area could overcome this.

Once the entire site is developed the seniors living precinct will have an alternative access via a new connection onto Grose Vale Road and this is unlikely to be cut by flooding.

Other parts of the entire development however may have their access cut for a few hours depending on the design of roads and bridges where they cross ephemeral water courses, the provision and location of flood detention storages and the interconnectivity of the road network providing alternative routes between points.

3.5 Flood Evacuation

The preceding analysis shows that riverine flooding does not pose a direct threat to the proposed North Richmond development and local flooding would only directly impact a small number of properties in the most extreme events.

The indirect impacts of either type of flooding is unlikely to trigger the mass evacuation of North Richmond.

However, should it be decided, either by the occupants or the SES, that restricted access or reduced services made staying in North Richmond untenable, there would remain a safe, flood free access route by which people could leave at any time.

This would mean that there would be no urgency to evacuate and the SES could time the evacuation so that it did not coincide with urgent evacuations from life threatening floodwaters.

The NSW SES bases its flood evacuation planning on an estimated vehicle evacuation rate of 600 vehicles per hour, per lane of outbound traffic (Opper, 2004). As explained in Section 0, there are nearly 1,600 dwellings currently in North Richmond and were the whole of the NRJV site to be developed that would increase to between 2,600 and 3,600 dwellings.

If a conservatively high figure of two vehicles per household were assumed (car ownership in the Hawkesbury is lower than this on average but reaches this in Baulkham Hills Shire) then a maximum total of 7,200 vehicles would need to be evacuated. This would take about 12 hours to evacuate. The evacuation of all of North Richmond and its surrounding area could therefore be evacuated in one day.

4 BUSHFIRE

4.1 Bushfire Risk Categories

Bushfire risk is defined as the chance of a bushfire igniting, spreading and causing damage to assets of value to the community. Risk may be rated as being extreme, major, moderate, minor or insignificant and is related to the vulnerability of the asset.

Assets which are exposed to an extreme/major bushfire risk are those that are located in an area of high bushfire hazard containing large areas of unmanaged bushland, remote from the safety provided by existing development. These assets require early relocation of the occupants when a bushfire event occurs that could cut evacuation routes and which could breach fire safety measures implemented in the design of a development.

Assets which are exposed to a moderate bushfire risk are those that are located in an area of moderate bushfire hazard, usually within an area that contains existing development and some unmanaged bushland/grassland which is exposed to periodic bushfire events. The bushfire risk to these assets is mitigated by the provision of bushfire protection measures such as the maintenance of Asset Protection Zones and construction standards to buildings.

Evacuation of properly prepared assets within a moderate bushfire risk area is not normally required for moderate to extreme bushfire events however exposure to a catastrophic fire event may require relocation of the residents to a safe refuge remote from the potential fire path.

Assets which are exposed to a minor/insignificant bushfire risk are those that are located within an existing urban area or rural residential precinct which provides minimum combustible fuels for fires to burn across and are located nominally 100 metres from the bushfire hazard interface. Evacuation of assets occupied by the frail/aged or people with respiratory illnesses may be required due to the potential for smoke impact.

4.2 Bushfire Risks

4.2.1 Existing Site

Hawkesbury City Council's Bushfire Prone Land Map (Figure 4) shows the whole of the existing site as being Category 2 vegetation which is open woodland/unmanaged grassland. However the site is actually managed grassland [grazed] with some scattered shade trees and narrow vegetated creek lines. This means that it has a much lower bushfire hazard than suggested by its classification on Council's maps.

The Bushfire Prone Land Map records the vegetation on the land to the north, west and south of the site as containing Category 1 Bushfire Prone Vegetation.

The adjoining landuse to the north and west consists of rural residential development that contains managed grassland vegetation with pockets of remnant Open Forest vegetation to the creek lines/watercourses. The bushfire risk presented by this vegetation is low to moderate with the north-western corner of the site being exposed to fires burning downslope along the riparian corridor to Redbank Creek.

The land to the south of the eastern portion of the site contains rural residential development with managed grassland vegetation which presents a low bushfire risk to this portion of the site.

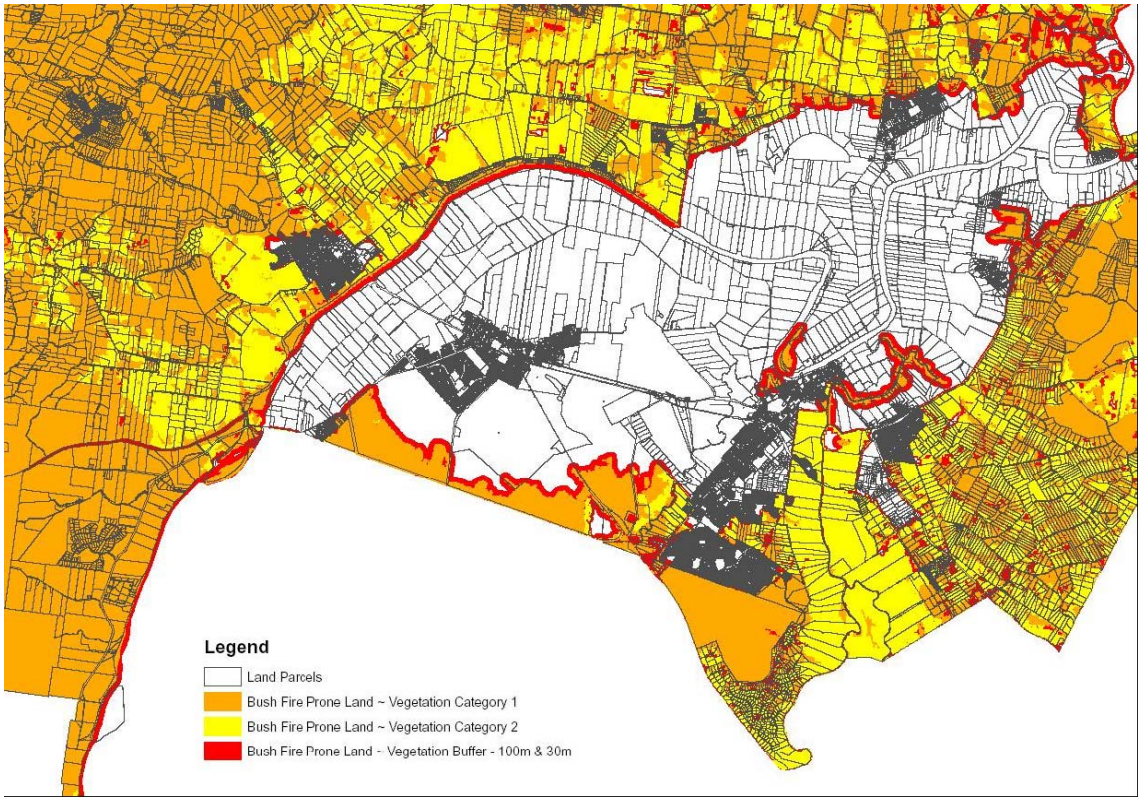

Figure 4: Bushfire Prone Land (From Hawkesbury LGA map)

The southern aspect of the western portion of the site contains land that slopes to the south and on which there is Category 1 Bushfire Prone Vegetation. Due to the topography of the land within the site falling from the ridgeline, and therefore below the influence of a bushfire event in this vegetation, the potential bushfire risk to this portion of the site is moderate.

The location of the site, downslope of any potential fire path from the northwest, west and southwest (except for the area of narrow ridge-top development along Grose Vale Road in the south-western corner), provides a location for future residential and retirement living development which will not be exposed to severe fire behaviour and is therefore deemed to have a low bushfire risk from the impact of bushfire events which may occur in the local area.

4.2.2 Future Site

Urban development on the land will result in the removal of some of the scattered trees and remove much of the grassland which will theoretically reduce the already low bushfire hazard over most of the site.

However, there is likely to be a requirement for all permanent and some ephemeral watercourses to have vegetated buffer zones extending from the top of each bank. These riparian corridors themselves can become bushfire prone land with a fire hazard greater than the existing grass land or even the current open woodland categorisation should they be quite wide. Fire protection measures will therefore be required to address this potential risk.

4.2.3 Indirect

To the northwest, west and southwest of the existing development within the Kurrajong, Grosse Vale and Grosse Wold districts are large tracts of undisturbed bushland within the Blue Mountains National Park. Large, intense bushfires occur at frequent intervals within this bushland.

Fires burning in the National Park will not, due to the separation provided by the existing development in the district, pose a direct risk to lives or property on the subject site but the smoke and embers from those areas could deposit onto the North Richmond area and create local fire ignitions of unmanaged vegetation and inconvenience to all and health impacts on those with respiratory illnesses or weak respiratory systems.

Furthermore, high winds that accompany severe fires can damage above ground infrastructure such as overhead electricity supplies. In the case of North Richmond any above ground electricity supplies coming into the area which pass through high wind areas and areas with a risk of bushfire could be susceptible.

4.3 Managing Bushfire Risks

4.3.1 Direct

There are five ways in which direct bushfire threat can be reduced:

1. Provide an asset protection zone between the buildings and bushfire prone vegetation;
2. Design and build buildings to resist the impacts of bushfire;
3. Provide appropriate access for emergency services to undertake fire fighting
4. Provide adequate water supplies for fire fighting
5. Manage the residual vegetation to reduce bushfire risks

It will be possible to design the future subdivision layout and construction of the built structures such that all of the statutory requirements for the above mitigation measures can be met.

4.3.2 Indirect – Smoke and Ember Attack

With regard to the indirect effects of bushfire on people there are basically two ways in which they can be dealt with:

a) Smoke

1. Seal buildings and stay indoors until the smoke has abated; or
2. Evacuate the area until the smoke has abated.

Either option would be available to most of the residents of North Richmond, including those in the proposed residential development on the site.

However, it may not be appropriate for some of the residents in the aged care facilities within the seniors living precinct to be evacuated elsewhere given the facilities and care to which they need access. At the same time they will include the most vulnerable people in the community with regard to respiratory weakness and illness so if they stay they need to be protected from the effects of the smoke.

This is best achieved by designing buildings which are easily sealed to exclude smoke and have air conditioning systems to regulate air quality and temperature. The air conditioning system would need an electrical power supply and, given that there is some risk of disruption to power by bushfires, the provision of emergency power supplies to the aged care facilities would be prudent.

b) Ember Attack:

1. Plant and maintain appropriate landscaping close to buildings;
2. Minimise the accumulation of dry, combustible fuels within the subdivision;
3. Provide protection to buildings to minimise the accumulation of combustible fuels in roof gutters and valleys.

The risk of ignition of vegetation/buildings can be minimised with appropriate management of fuels and construction standards to the buildings.

4.3.3 Evacuation Planning

There is no bushfire evacuation plan for the North Richmond area which is equivalent to the SES plan for the evacuation of the Hawkesbury Nepean Valley during major floods.

Bushfire evacuation planning is implemented as part of the emergency planning provisions of Section 52(1)(a) and Section 53 of the *Rural Fires Act 1997* and is implemented, under instructions from the lead combat fire agency (NSW Rural Fire Service or NSW FB), by the NSW Police or SES under delegation from the Police.

Under Section 44 of the *Rural Fires Act 1997*, the Commissioner of the NSW Rural Fire Service is to take charge of bushfire fighting operations and bushfire prevention measures and to take such measures as the Commissioner considers necessary to control or suppress any bushfire.

Such measures also include the relocation (evacuation) of persons deemed to be at risk from a bushfire. The decision to evacuate an area/facility is normally delegated by the Commissioner to the Incident Controller appointed by the Commissioner under the provisions of Section 44 of the *Rural Fires Act 1997.*

The decision to evacuate the North Richmond region will be made by that person, in consultation with the combat agencies and support groups and will be made having consideration to the safety of the people and the status of the bushfire protection measures that are in place.

It is Rural Fire Service policy not to evacuate able bodied persons who are located in an area/development which is well prepared and protected against the likely impacts of a bushfire, including the residual impacts of fires burning remote to an area – i.e. smoke and ember attack. The exception to this policy is the young, frail and aged or people with respiratory illness, unless they are not directly exposed or can be protected against the impacts of the bushfire event.

Such protection can be provided by appropriately designed bushfire protection measures such as Asset Protection Zones, building construction including the provision of air-conditioned spaces and the management of landscaped spaces surrounding buildings.

It is reasonable to assume that the Bells Line of Road to the west of North Richmond has the greatest risk of being cut by bushfires while to the east and across the floodplain to Richmond there is a negligible risk of the roads being cut by bushfires.

This means that should people want to leave, or are instructed to evacuate North Richmond, they would able to safely do so when they chose to – relocating to the safety provided by the township of Richmond.

There is no reason to believe that evacuation from the North Richmond district, if deemed necessary by the emergency services, could not be undertaken in an orderly manner. The time required is not likely to be any greater than the 12 hours needed for flood evacuation and may take less time. Able bodied evacuees could be accommodated at the Richmond Air Force Base, Richmond High School or the University of Western Sydney Hawkesbury Campus whilst those persons evacuated due to illness could be relocated at to the Windsor Hospital or the Nepean Hospital at Penrith.

5 CONCLUSIONS

NRJV's North Richmond site can be considered to be:

- Free of any direct risk of flooding from the Hawkesbury Nepean River;
- Free from any direct threat of a major bushfire;
- At risk of minor local floods and low intensity bushfires along riparian corridors on site.

It will be possible to manage the impacts of localised floods and bushfires by:

- Incorporating mitigation measures in the design and management of the riparian corridors; and
- Adopting current best practices in flood and fire safety in the designs of subdivisions, roads, bridges and buildings.

Major to extreme floods on the Hawkesbury Nepean River:

- will cut North Richmond's most direct road access across the River
- will cut grid electricity supplies to North Richmond
- will cut telephone communication to North Richmond
- will reduce the amount of treated drinking water to North Richmond
- will cut access to Hawkesbury Hospital at Windsor and increase travelling time to Nepean Hospital at Penrith by about 1.5 hours

These indirect effects of flooding will be able to be mitigated by:

- deferring trips across the river, travelling to similar destinations in North Richmond, Katoomba or Lithgow or detouring through Katoomba and Penrith
- including renewable energy supplies, energy efficiency measures and emergency power generation in parts or all of the proposed development
- including rainwater harvesting and water efficiency measures in the proposed development
- providing a helicopter landing area in the seniors living precinct for emergency medical transport to Nepean Hospital

These indirect flood impacts will be no worse and in many cases less severe than the impacts on areas on the floodplain east of the River.

Major bushfires in the bushland to the northwest, west and southwest of North Richmond, within the Blue Mountains National Park, could create smoke concentrations which may cause breathing difficulties for people particularly if they have a pre-existing respiratory complaint. This indirect bushfire impact can be mitigated by:

- people evacuating North Richmond until the smoke has abated
- people staying indoors with the building sealed until the smoke has abated
- ensuring the aged care facilities are easily sealed, have air conditioning and have an emergency power supply

While it is unlikely that either bushfire or flood would require the evacuation of the proposed development, it is recognised that in the most extreme events many people

may voluntarily choose to leave or may be instructed to do so by the SES in floods or the NSW Rural Fire Service via the Police during bushfires.

Were this to be the case, the entire existing population of North Richmond as well as those in the new development could be evacuated to an unaffected location within 12 hours although there would be no urgency requiring it to be done this quickly.

6 REFERENCES

Department of Planning (2007) *Direction No 15 – Flood Prone Land Section 117 EP&A Regulation Ministerial Directions*

Department of Planning (2007) *Guideline on Development Controls on Low Flood Risk Areas – Floodplain Development Manual*

Hawkesbury City Council (1989) *Hawkesbury Local Environment Plan*, Updated 2006

NSW Department of Infrastructure, Planning and Natural Resources (2005) *Floodplain Development Manual*

NSW State Emergency Service (2003) *Pitt Town Local Environmental Study Flood Emergency Risk Management Revised Analysis of Urban Growth Impact*

NSW State Emergency Service (2005) *Hawkesbury Nepean Flood Emergency Sub Plan (HNFESP): A Sub Plan of NSW DISPLAN*, NSW State Emergency Service, December 2005.

Opper, S. (2004) *The Application of Timelines to Evacuation Planning*, FMA Conference Coffs Harbour, 2004.

Sydney Water Corporation (1995) *Proposed Warragamba Flood Mitigation Dam Environmental Impact Statement*

Urbis (2007) *Social Infrastructure Assessment – North Richmond*

Appendix A

Steven Molino CV

MOLINO STEWART
ENVIRONMENT & NATURAL HAZARDS

STEVEN MOLINO
Curriculum Vitae

Qualifications

Bachelor of Science (Physical Geography and Environmental Chemistry). University of New South Wales, 1984.

Bachelor of Engineering (Civil) (Hons). University of New South Wales, 1984.

RABQSA Certified Lead Environmental Auditor (13515)

Certificate IV in Assessment & Workplace Training.

Career

1995+	Principal Molino Stewart
1990-95	Senior Associate ERM Mitchell McCotter
1986-90	Environmental Scientist NSW Electricity Commission
1985	Construction Engineer NSW Electricity Commission
1984	Design Engineer NSW Electricity Commission
1979-83	Cadet Engineer NSW Electricity Commission

Affiliations

Corporate Member, Institution of Engineers, Australia

Registered Professional Engineer NPER 3 Civil and Environmental (1053737)

Biography

Steven is a founding principal of Molino Stewart. He has demonstrated a high level of skill in handling the environmental approval of a number of large contentious projects. He is particularly adept at assisting clients formulate options for achieving objectives and then using a technique known as multi criteria analysis to evaluate the options. Steven has used this successfully to help groups with diverse views reach consensus. Steven has particular expertise in flood response planning, environmental auditing and hazardous waste management. His strong interpersonal skills have been used to good effect in workshop facilitation, community consultation programs and training.

Floodplain Management

Emergency Planning

- **VICSES Role in Flood Education and Warning** *(Victorian State Emergency Service):* Reviewed the role of the SES in flood education and flood warning with recommendations to SES Board on appropriate actions and resources to improve both through SES initiatives.
- **Penrith Lakes Development** *(Planning NSW).* Provided expert advice on evacuation strategies, life and property protection and flood planning levels for a proposed 5,000 dwelling development on a rehabilitated mining site on a Nepean River floodplain.
- **Pitt Town Evacuation Review** *(Hawkesbury City Council).* Provided an independent review of SES reports into evacuation of a proposed 1,000 lot residential development at Pitt Town on the Hawkesbury Floodplain.
- **North Bligh Park Evacuation Strategy** *(Moore Development Group):* Reviewed adequacy of proposed evacuation infrastructure and provided independent advice on the integration of evacuation traffic from a new 1,000 lot urban development with regional flood evacuation traffic in the Hawkesbury Nepean Valley.
- **Camden Residential Development** *(AEH Group):* Evaluated the flood safety and evacuation risks for a 170 residential unit and 50 bed aged care hostel.
- **Penrith Panthers Redevelopment** *(ING Real Estate):* Advising on design aspects to manage flood safety risks on redevelopment and expansion of the 70ha site for entertainment, recreational, commercial, tourism and residential development.
- **West Dapto Flood Access** *(Growth Centres Commission):* Evaluated the impacts of flooding on accessibility for various road network upgrade options for future development of a 14,000 lot growth centre.
- **Grafton Evacuation Review** *(Clarence Valley Council):* Evaluating the flood evacuation plans for 12,000 people from Grafton.
- **Currumbin Shopping Centre** *(Bourse):* Assessing flood risks associated with a proposed shopping centre development and working with designers to address risks.
- **Merrimac Residential Development** *(Lenmarc):* Assessing flood safety risks and developing evacuation plan for 100 lot residential development on Gold Coast floodplain
- **Chinderah Flood Risk** *(Seekchange):* Pre-purchase assessment of flood risks and advice on potential for residential development approval within current and proposed flood planning controls.
- **Riverstone West Flood Evacuation and Education Plan** *(Paclib):* Developed a flood education and evacuation plan for a proposed 300ha industrial and commercial development.
- **Flood Reference Report** *(NSW State Emergency Service).* Drafted a Hawkesbury-Nepean Flood reference report for the State Emergency Service.
- **Business Continuity Toolkit** *(State Emergency Service).* Designed a toolkit to assist businesses to develop business continuity plans to reduce the commercial losses of flooding.
- **Home Floodsafe Toolkit** *(NSW State Emergency Service):* Designed a toolkit to assist householders to develop flood plans to reduce the losses and disruption of floods.
- **Caravan Park Flood Response Guidelines** *(Shoalhaven City Council):* Working with Bewsher Consulting to develop flood response guidelines for about 40 flood prone caravan parks in the Shoalhaven Region.
- **Flood Response Plan Guidelines** *(Gold Coast City Council):* Preparing guidelines for the development of Flood Response Plans for individual developments on Gold Coast floodplains.

- **Planning Infrastructure for Flood Hazards** (*Hawkesbury Nepean Floodplain Management Steering Committee*). Consulted with major infrastructure owners and managers to determine their level of awareness of flooding and the strategies which they had in place to protect or replace assets and to maintain or restore service in the event of a flood. Developed briefing papers to guide and assist service providers develop response and recovery programs.
- **Tsunami Warning Systems** *(NSW State Emergency Service):* Investigated available and emerging technologies for the dissemination of tsunami warning information along the NSW coast.
- **Comparative Evaluation of Warning Technologies** *(State Emergency Service).* Investigated and compared old, new and emerging technologies for disseminating flood alert and warnings.
- **Integrated Flood Warning System** *(State Emergency Service).* Developed a methodology for selecting a combination of warning methods and technologies to ensure maximum coverage and minimum failure risk.
- **Tamworth Tyre Centre** *(Taylor Kelso Solicitors)* Provided expert evidence to the NSW Land and Environment Court into the risks associated with a commercial development on the Peel River floodplain.
- **Parraweena Road Development** *(SMEC):* Provided expert evidence of flood evacuation to the Land and Environment Court for a proposed commercial development in the Sutherland Shire.
- **Hoxton Park Training Facility** *(Integral Energy)*: Evaluated flood safety risks and advised on design features to aid safe flood evacuation of an apprentice training facility
- **Nursing Home Flood Response Plan Review** *(Gold Coast City Council):* A proposed expansion of a 300 person nursing home and retirement village in the Nerang Valley required the development of a comprehensive flood response plan. Provided an independent review of the plan suggesting significant changes to assumptions and actions
- **North Coast Evacuation Evaluation** *(NSW State Emergency Service):* Conducted door to door survey of properties on the NSW North Coast following a major flood to determine the effectiveness of flood and evacuation warnings and gauge community attitudes to flood risks and response.
- **Hunter Flood Warning Evaluation** *(NSW State Emergency Service):* Evaluated the effectiveness of flood warnings in the Hunter Valley during the June 2007 floods.
- **Gippsland Flood Warning Evaluation** *(Victoria State Emergency Service):* Evaluated the effectiveness of flood warnings in Gippsland during the June 2007 floods.
- **North Coast Evacuation Evaluation (NSW SES):** Conducted focus groups and on-line survey and reviewed warning procedures and content to evaluate the appropriateness and effectiveness of flood warnings for major flooding on three river systems.
- **High Rise Development Flood Response** *(Minter Ellison):* Assessing flood emergency evacuation and flood response planning for a proposed 270 apartment and commercial complex as part of a Planning and Environment Court appeal.
- **Yarra River Commercial Development** *(Freehills):* Provided expert opinion on flood evacuation planning for a proposed commercial development on the banks of the Yarra River.

Impacts and Mitigation

- **Duck River Floodplain Risk Management Study and Plan** *(Parramatta City Council):* Producing study and plan for 40 square kilometre, fully developed urban catchment in western Sydney where the 1% flood affects more than 1,000 properties across four local government areas. Many parts of the remaining open space within the floodplain has high biodiversity values and the communities are culturally and linguistically diverse.
- **Warragamba Auxiliary Spillway** *(SWC).* Project manager for a project to bring Sydney's major water supply dam up to international safety standards. A major consideration was finding the appropriate balancing between project costs and downstream flood risks.

Floodplain Management (cont)

- **Warragamba Flood Mitigation Dam** (*SWC*). Conducted workshops, tours and interactive displays to explain the environmental impacts of a proposed mitigation dam which could have potentially impacted on more than 75 square kilometres of natural areas including national parks and wilderness areas, 200 kilometres of river system, 400 square kilometres of floodplain and a village of 1,800 people. This was a highly controversial project which required consultation with government, peak conservation groups and local residents.
- **Keepit Dam Upgrade** *(State Water)* Part of an expert panel advising on the flood damage, environmental impact and socio economic implications of options to upgrade Keepit Dam.
- **Flood Damage Methodology Review** *(confidential client)* Undertook an independent review of a methodology for estimating flood damage exposure for a major insurance company.
- **Victorian Flood Damages** *(Department Sustainability and Environment)* Part of a team using a rapid appraisal method to estimate flood damages across the whole of Victoria and estimating the benefits of various interventions to help prioritise areas for future detailed investigations.
- **Hawkesbury-Nepean River Flood Damages** (*NSW Inter-Departmental Committee*). Estimated the direct, indirect, tangible and intangible cost of flooding in the Hawkesbury Nepean Valley where 17,000 homes, 4,000 businesses and billions of dollars worth of key infrastructure is flood liable.
- **Effects of Hawkesbury-Nepean River Flooding on Communities and Infrastructure** (*Hawkesbury Nepean Flood Management Advisory Committee*). Assessed impacts of flooding on assets and communities and advised on measures to reduce impacts.
- **Review of Recent and Future Hawkesbury Nepean Development for Emergency Planning** *(NSW SES)* Reviewing recent and proposed urban and infrastructure development on and adjacent to the floodplain to determine implications for emergency planning.
- **North Richmond Flood Hazard Evaluation** *(BuildDev):* Reviewed the flood hazards related to a proposed 2,500 lot residential development in the Hawkesbury Nepean Valley. Compared the flood risks for the site with five other potential development sites in the LGA.
- **Woronora River House Raising Scheme** (*Sutherland Shire Council*). Developed a scheme for subsidising the raising of houses which are at a high risk of suffering damage from flooding

Stakeholder Engagement

- **Victorian Flood Web Portal** *(Goulburn Broken CMA):* Developing a web portal as a one-stop location for all information about flooding in Victoria and what to do before, during and after a flood.
- **Woronora River Flood Preparedness Strategy** (*Sutherland Shire Council*). Developed a community awareness and education package to alert residents along the Woronora River of the dangers of flooding and how to respond to the new flood warning system.
- **Woronora Flood Preparedness Evaluation** (*Emergency Management Australia*). With the assistance of a research grant evaluated the effectiveness of the Woronora River Flood Preparedness Strategy five years after implementation.
- **Local Government Flood Communication** (*Hawkesbury Nepean Flood Management Steering Committee*) Designed and delivered training for local government officers who would have to deal with flood issue inquiries from community members.
- **Blowering Dam Upgrade** *(State Water)* Provided expert advice on strategies for communicating dam failure risks to key stakeholders.
- **Community Engagement Training** (*Emergency Management Australia*). Provided training in engaging with and preparing communities for emergency response.

- **Beverly Park and Poulton Park Community Engagement** *(Kogarah Council)* Designed and delivered strategies for engaging with the flood affected community in these small urban catchments in accordance with the procedures in the NSW Floodplain Development Manual.
- **Upper Parramatta River FloodSafe** *(Upper Parramatta River Catchment Trust).* Developing a community education program for the four local government areas in the Upper Parramatta catchment to reduce commercial and residential the impacts of flooding.
- **Lower Parramatta River Flood Workshop** *(Parramatta City Council).* Facilitated a workshop for property owners and occupiers who are in areas identified as having a medium to high flood hazard to help them better understand their risks and what they and council are able to do to manage risks.
- **Newport Flood Preparedness** *(Pittwater Council).* Designing and delivering a community education program, including a review of Council processes for dealing with the public, for an urban catchment with high flood risks.
- **Rockdale Flood Education Strategy** *(Rockdale Council)* Designed and delivered elements of a flood education strategy for Rockdale Local Government Area.
- **Stakeholder Engagement Strategy** *(Holroyd City Council):* Prepared a stakeholder engagement strategy in relation to flooding following negative community feedback from a Council proposal to introduce a Development Control Plan to manage the effects of overland flows and main channel flooding up to the PMF.
- **Floodplain Manager.** Editor of a bi monthly newsletter to connect and inform floodplain managers throughout Australia. This was an initiative of Molino Stewart.

Expert Testimony

- **Tamworth Tyre Centre** *(Taylor Kelso Solicitors)* - expert evidence to the NSW Land and Environment Court into the risks associated with a commercial development on the Peel River floodplain.
- **Parraweena Road Development** *(SMEC):* Provided expert evidence of flood evacuation to the NSW Land and Environment Court for a proposed commercial development in the Sutherland Shire.
- **High Rise Development Flood Response** *(Minter Ellison):* Assessing flood emergency evacuation and flood response planning for a proposed 270 apartment and commercial complex as part of a QLD Planning and Environment Court appeal.
- **Yarra River Commercial Development** *(Freehills):* Provided expert opinion in the Victorian Civil and Administrative Tribunal on flood evacuation planning for a proposed commercial development on the banks of the Yarra River.
- **Water Pollution Prosecution, Port Hacking.** *(Minter Ellison)* **–** expert evidence on water quality issues
- **Water Pollution Prosecution, Hacking River** *(Minter Ellison)* - expert evidence on water quality issues
- **Tourist Development, Canyonleigh** *(Environmental Defenders Office)* - expert evidence on water quality issues
- **Commission of Inquiry into Blue Mountains LEP 1997** (*Hammon Holdings and Lakeview Holiday Park*)
- **Commission of Inquiry into Blue Mountains LEP 1988** *(Elcom)*

Published Technical Papers

- Molino S., *Unifying Flood Information – The Victorian Flood Web Portal.* 49th Floodplain Management Authorities of NSW Annual Conference, 2009

- Cameron-Smith C., Gissing A., Molino S., *How do you Improve Community Response to Warnings?* 48th Floodplain Management Authorities of NSW Annual Conference, 2008

- Molino S. *Think or Swim – Planning Developments so Lifebuoys Aren't Needed*. 47th Floodplain Management Authorities of NSW Annual Conference, 2007

- Molino S. *Business Responsibility in Vulnerable Coastal Regions*. Coastal Cities Natural Disasters Conference, Sydney 2007

- Molino S., Opper S., Gissing A., Edwards G., *To Flee of Not to Flee – An Evaluation of Warning and Evacuation Effectiveness.* 46th Floodplain Management Authorities of NSW Annual Conference, 2006

- Molino S., *The Po River – 2,000 Years of History.* 45th Floodplain Management Authorities of NSW Annual Conference, 2005

- Molino S., Gissing A., *Lessons From the Past are Not Always Used – Business Flood Preparedness in Two NSW Communities.* 45th Floodplain Management Authorities of NSW Annual Conference, 2005

- Molino S., Huybrechs J., *Do Education Strategies Sink and Communities Swim? Evaluation of the Woronora Strategy Five Years On.* 44th Floodplain Management Authorities of NSW Annual Conference, 2004

- Molino S., *Floodplain Development – What Merits Assessment?* 44th Floodplain Management Authorities of NSW Annual Conference, 2004

- Molino S., *Dismantling Human Barriers to Flood Warning*. 43rd Floodplain Management Authorities of NSW Annual Conference, 2003

- Molino S, Begg G, Opper S, *Bells and Whistles, Belts and Braces – Designing an Integrated Flood Warning System for the Hawkesbury Nepean Valley – Part 2 Belts and Braces.* Flood Plain Management Authorities 42nd Annual Conference, 2002 and Australian Journal of Emergency Management Spring 2002

- Molino S, Begg G, Opper S, *Bells and Whistles, Belts and Braces – A Preliminary Analysis of New and Emerging Warning Technologies.* Flood Plain Management Authorities 41st Annual Conference, 2001 and Australian Journal of Emergency Management Autumn 2002.

- Molino S and Rogers M, *New Flood Preparedness Ideas for an Inexperienced Urban Community.* Flood Plain Management Authorities 39th Annual Conference, 1999

- Molino S., *Practical Difficulties in Prosecuting Environmental Offenders.* Environmental Crime. Proceedings of a Conference, Australian Institute of Criminology, Canberra, 1995

- Snape D. and Molino S., *Warragamba Dam Upgrade Progress Paper.* ANCOLD Conference on Dams, Hobart, November 1994